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For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

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(54) Title: METHOD FOR PRODUCING MODELS

(57) Abstract: The invention relates to a method for producing models or pre-forms, comprising the following method steps: (a) producing a shaped core from a water-soluble block material, (b) coating the shaped core with a curable polymer, (c) curing the curable polymer at from 25 to 250 °C, and (d) removing the core material by treating the coated core with water.

Method for producing models

The present invention relates to a method for producing models or pre-forms by the "lost core" method.

A conventional method for producing plastics models of complex mouldings having cavities requires a negative prototype to be modelled from a block material, which is then coated with a curable polymer. After the polymer has been fully cured, the inner block material is removed ("lost core"). Depending upon the nature of the block material used and of the polymer cured, removal is carried out by melting or by dissolving in a suitable solvent. Wax, polystyrene or other meltable plastics mixtures have hitherto been used as block materials. In SAMPE Journal, Vol. 36, No. 4, 46-48 (2000), a polyisocyanurate foam is proposed for producing motor housings. The polyisocyanurate foam is easy to process, is temperature-resistant up to 180°C and is compatible with various synthetic resins, for example epoxides, bismaleimides and phenolic resins. Removal of the block material is carried out using high-pressure washing systems.

The problem of the present invention was to simplify the known methods and to reduce the amount of waste.

The present invention relates to a method for producing models or pre-forms, comprising the following method steps:
(a) producing a shaped core from a water-soluble block material,
(b) coating the shaped core with a curable polymer,
(c) curing the curable polymer at from 25 to 250°C, and
(d) removing the core material by treating the coated core with water.

The environmental burden of the method according to the invention is minimal because no organic solvents are used and the water-soluble block material can be recovered and recycled.

Production of the shaped core in method step (a) is carried out by known shaping methods, for example milling, grinding, casting or compression moulding.

The water-soluble block material should be capable of being shaped easily and have some degree of temperature-resistance.
Preferred block materials are water-soluble polymers, for example polyacrylic acid, polymethacrylic acid and, especially, polyvinyl alcohol.

It is advantageous to apply a parting agent to the shaped core before it is coated with the curable polymer. Suitable parting agents are, for example, fatty acids, fatty acid esters, fatty acid salts, e.g. zinc stearate or calcium stearate, and silicones. Instead of coating with a parting agent, it is also possible to wrap the shaped core with a Teflon tape.

The polymer used in method step (b) can be a thermally curable or radiation-curable polymer. Preference is given to the use of a thermally curable (thermosetting) polymer.

Suitable curable polymers are, for example, epoxy resins, phenolic resins, unsaturated polyesters, bismaleimides, polyimides and polyurethanes.

Special preference is given to epoxy resins.

Examples of suitable epoxy resins are diglycidyl ethers of bisphenols, e.g. diglycidyl ether of bisphenol A and diglycidyl ether of bisphenol F, epoxy phenol novolaks, epoxy cresol novolaks, cycloaliphatic epoxy resins, e.g. 3,4-epoxycyclohexylmethyl 3',4'-epoxycyclohexanecarboxylate, diglycidyl tetrahydrophthalate, diglycidyl 4-methyltetrahydrophthalate, diglycidyl hexahydrophthalate and diglycidyl 4-methylhexahydrophthalate, and N-glycidyl compounds such as triglycidyl isocyanurate.

The curable polymer can comprise customary auxiliaries and additives, for example antioxidants, light stabilisers, flame retardants, fillers, plasticisers, dyes, pigments, thixotropic agents, toughness improvers, antifoams, antistatics, lubricants and mould-release aids.

The curable polymer preferably comprises fillers in powder form, for example quartz powder or aluminium oxide.

The shaped core is generally coated with the curable polymer by conventional methods, for example application by injection, spraying, casting, the filament winding technique or the hand lay-up method.

The curable polymer is then fully cured at room temperature or at elevated temperature, the curing temperature and duration of curing depending both on the nature of the curable polymer and on the hardener and/or accelerator chosen. Suitable hardeners and curing accelerators will be well known to the person skilled in the art.
Preference is given to the selection of a resin/hardener system that fully cures in the temperature range from 50 to 150°C, especially from 80 to 140°C.

The curing process can be carried out at normal pressure in an oven or under pressure in an autoclave.

After curing of the polymer, the shaped core can be removed very simply by dissolving in water. Most simply, that is carried out by immersing the coated core in a water bath.
In the case of very soluble block materials, for example polyvinyl alcohol, the use of cold water is sufficient; less readily soluble materials can be removed using warm or hot water or by the use of pressure.

Preference is given to carrying out method step (d) at room temperature (15 - 25°C) and under normal pressure (900 -1100 hPa).

After method step (d) has been carried out, the filler optionally contained in the block material can be recovered and put to the same or some other use.

The water-soluble block material can also be completely recovered by evaporating off the water.

Example 1

A mixture of 10 parts by weight of polyvinyl alcohol and 100 parts by weight of $Al_2O_3 \cdot 3H_2O$ is shaped into a negative model of a hollow article. An epoxy resin/hardener mixture (diglycidyl ether of bisphenol A) is then applied to the negative model. Pretreatment with a

parting agent is not necessary. The time for full cure depends on the layer thickness of the block; for each centimetre of layer thickness, curing for 1 hour at at least 60°C is necessary. After full cure, the block material is dissolved out from the inside of the hollow article in water.

Example 2

A mixture of 20 parts by weight of polyvinyl alcohol and 100 parts by weight of ALU DIN 100 (aluminium powder, 100 µm) is shaped into a negative model of a hollow article. An epoxy resin/hardener mixture (diglycidyl ether of bisphenol A) is then applied to the negative model. Pretreatment with a parting agent is not necessary. The time for full cure depends on the layer thickness of the block; for each centimetre of layer thickness, curing for 1 hour at at least 60°C is necessary. After full cure, the block material is dissolved out from the inside of the hollow article in water.

What is claimed is:

1. A method for producing models or pre-forms, comprising the following method steps:
   (a) producing a shaped core from a water-soluble block material,
   (b) coating the shaped core with a curable polymer,
   (c) curing the curable polymer at from 25 to 250°C, and
   (d) removing the core material by treating the coated core with water.

2. A method according to claim 1, wherein a water-soluble polymer is used as the block material in method step (a).

3. A method according to claim 2, wherein polyvinyl alcohol is used as the block material in method step (a).

4. A method according to claim 1, wherein the curable polymer in method step (b) is selected from epoxy resins, phenolic resins, unsaturated polyesters, bismaleimides, polyimides and polyurethanes.

5. A method according to claim 1, wherein the curing of the curable polymer in method step (c) is carried out at from 50 to 150°C.

6. A method according to claim 1, wherein method step (d) is carried out at room temperature (15 - 25°C) and under normal pressure (900 -1100 hPa).

INTERNATIONAL SEARCH REPORT

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A. CLASSIFICATION OF SUBJECT MATTER
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According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 B29C

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)
EPO-Internal, WPI Data, PAJ

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	DE 195 34 836 A (RIESSELMANN F & H KUNSTSTOFF) 27 March 1997 (1997-03-27) the whole document	1-6
X	US 5 184 874 A (OLSON PAUL D ET AL) 9 February 1993 (1993-02-09) column 2, line 57 - line 60 column 4, line 33 - line 66	1-6
X	DATABASE WPI Section Ch, Week 8437, September 1984 (1984-09) Derwent Publications Ltd., London, GB; Class A32, AN 1984-228589'37! XP002173854 & JP 59 136214 A (NIIGATA ENG CO LTD), 4 August 1984 (1984-08-04) abstract; figures	1,2,4-6

☐ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

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"&" document member of the same patent family

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INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No
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